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IN THE CLAIMS

Please amend the claims as follows, substituting any amended claim(s) for the corresponding pending claim(s):

| 1 | 1. | (Original) A radio frequency integrated circuit (RFIC) comprises: |
|---|---------|---|
| 2 | | transmitter section operably coupled to convert outbound baseband signals into outbound radio |
| 3 | frequer | ncy (RF) signals; |

receiver section operably coupled to convert inbound RF signals into inbound baseband signals, wherein the receiver section includes: a low noise amplifier operably coupled to amplify the inbound RF signals to produce amplified inbound RF signals;

down-conversion module operably coupled to convert the amplified inbound RF signals into baseband in-phase components and quadrature components;

9 orthogonal-normalizing module operably coupled to:

obtain a first coefficient that is based on at least one of power of the baseband in-phase components, power of the baseband quadrature components, and cross-correlation between the baseband in-phase components and the baseband quadrature components;

obtain a second coefficient that is based on at least one of the power of the baseband inphase components, the power of the baseband quadrature components, and the cross-correlation between the baseband in-phase components and the baseband quadrature components;

normalize an orthogonal relationship between the baseband in-phase components and the baseband quadrature components based on the first coefficient and the second coefficient to produce normalized in-phase components and normalized quadrature components; and baseband processor operably coupled to recapture data from the normalized in-phase and quadrature components.

2. (Original) The RFIC of claim 1, wherein the orthogonal-normalizing module comprises:

a first multiplier module operably coupled to multiple the baseband in-phase components with the first coefficient to produce the normalized in-phase components;

a second multiplier module operably coupled to multiple the baseband in-phase components with the second coefficient to produce the cross-correlation; and

a subtraction module operably coupled to subtract the cross-correlation from the baseband
 quadrature components to produce the normalized quadrature components.

(Original) The RFIC of claim 2, wherein the first multiplier module comprises:
 a first plurality of shift registers operably coupled to produce a plurality of shifted representations

3 of the baseband in-phase components:

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switch matrix operably coupled to pass selected ones of the plurality of shifted representations of the baseband in-phase components and the baseband in-phase components based on the first coefficient; and

an adder operably coupled to add the selected ones of the plurality of shifted representations of
the baseband in-phase components and the baseband in-phase components to produce the normalized inphase components.

4. (Original) The RFIC of claim 2, wherein the second multiplier module comprises:

a first plurality of shift registers operably coupled to produce a plurality of shifted representations
 of the baseband in-phase components;

switch matrix operably coupled to pass selected ones of the plurality of shifted representations of the baseband in-phase components based on the second coefficient; and

an adder operably coupled to add the selected ones of the plurality of shifted representations of
 the baseband in-phase components to produce the cross-correlation.

- (Original) The RFIC of claim 1, wherein the orthogonal-normalizing module comprises:
- a first multiplier module operably coupled to multiply the baseband in-phase components with the second coefficient to produce the cross-correlation;
- 4 a subtraction module operably coupled to subtract the cross-correlation from the baseband
 5 quadrature components to produce phase adjusted quadrature components; and
 - a second multiplier module operably coupled to multiply the phase adjusted quadrature components with the first coefficient to produce the normalized quadrature components, wherein the baseband in-phase components are passed as the normalized in-phase components.
- 1 6. (Currently Amended) The RFIC of claim 1, wherein the orthogonal-normalizing module comprises:
- 3 a first programmable register for storing the first coefficient; and
- a second programmable register for storing the second coefficient, wherein the first and second
 coefficients are determined by a trail and error manufacturing test-trial and error manufacturing test.

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7. (Original) The RFIC of claim 1, wherein the orthogonal-normalizing module comprises: a full matrix multiply module operably coupled to multiply the baseband in-phase components and the baseband quadrature components with a coefficient matrix that includes the first and second coefficients to produce the normalized in-phase components and the normalized quadrature components.

 (Original) The RFIC of claim 1, wherein the orthogonal-normalizing module further functions to: measure local oscillation leakage power to produce a first power measurement;

provide a first magnitude signal to an in-phase portion of the receiver section and a zero

magnitude signal to a quadrature portion of the receiver section;

5 measure power of the in-phase portion and power of the quadrature portion while processing the
6 first magnitude signal and the zero magnitude signal, respectively, to produce a second power
7 measurement;

provide the first magnitude signal to the quadrature portion of the receiver section and the zero magnitude signal to the in-phase portion of the receiver section;

measure the power of the in-phase portion and the power of the quadrature portion while processing the zero magnitude signal and the first magnitude signal, respectively, to produce a third power measurement;

determine a gain imbalance based on the first, second, and third power measurements; provide a second magnitude signal to the in-phase portion and to the quadrature portion; measure the power of the in-phase and quadrature portions while processing the second magnitude signal to produce a fourth power measurement;

provide the second magnitude signal to the in-phase portion and a negative second magnitude signal to the quadrature portion;

measure the power of the in-phase portion and the power of the quadrature portion while
processing the second magnitude signal and the negative second magnitude signal, respectively, to
produce a fifth power measurement; and

determine a phase imbalance based on the first, fourth, and fifth power measurements, wherein the gain imbalance and the phase imbalance correspond to the power of the baseband in-phase components, the power of the baseband quadrature components, and the cross-correlation between the baseband in-phase components and the baseband quadrature components to determine the first and second coefficients.

- 9. (Original) The RFIC of claim 1, wherein the orthogonal-normalizing module further functions to
 obtain the first and second coefficients by:
- measuring in-phase signal level of the receiver section while processing a sine wave;
 measuring quadrature signal level of the receiver section while processing the sine wave;
- determining the power of the baseband in-phase components based on the in-phase signal level;
 determining the power of the baseband quadrature components based on the quadrature signal
- 7 level;
- 8 determining cross-correlation power based on the in-phase signal level and the quadrature signal 9 level; and
- determining the first and second coefficients based on the power of the baseband in-phase
 components, the of the baseband quadrature components, and the cross-correlation power.
- 1 10. (Original) The RFIC of claim 1, wherein the orthogonal-normalizing module normalizes the
 corthogonal relationship between the baseband in-phase components and the baseband quadrature
 components by:
- selecting one of the baseband in-phase components and the baseband quadrature components as a
 reference component; and
- 6 normalizing another one of the baseband in-phase components and the baseband quadrature 7 components to the reference component.
- 11. (Original) The RFIC of claim 1, wherein the orthogonal-normalizing module further functions to:
 update the first and second coefficients to compensate for at least one of temperature variation and aging.

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12. (Original) A radio frequency integrated circuit (RFIC) comprises:

transmitter section operably coupled to convert outbound baseband signals into outbound radio frequency (RF) signals;

receiver section operably coupled to convert inbound RF signals into inbound data, wherein the receiver section includes; a low noise amplifier operably coupled to amplify the inbound RF signals to produce amplified inbound RF signals:

down-conversion module operably coupled to convert the amplified inbound RF signals into baseband in-phase components and quadrature components;

orthogonal-normalizing module including:

an in-phase power module operably coupled to determine power of the baseband in-phase components;

a quadrature power module operably coupled to determine power of the quadrature components:

a cross-correlation power module operably coupled to determine a cross-correlation power based on the baseband in-phase and quadrature components; and

normalizing module operably coupled to normalize the baseband in-phase components and the baseband quadrature components based on the power of the baseband in-phase components, the power of the baseband quadrature components, and the cross-correlation power to produce normalized in-phase components and normalized quadrature components; and baseband processor operably coupled to recapture the inbound data from the normalized in-phase

- 13. (Original) The RFIC of claim 12, wherein the normalizing module comprises:
- 2 a coefficient module operably coupled to determine coefficients based on the power of the 3 baseband in-phase components, the power of the baseband quadrature components, and the crosscorrelation power, wherein the baseband in-phase components and the baseband quadrature components
- 5 are normalized based on the coefficients.

and quadrature components.

- 1 14 (Original) The RFIC of claim 12, wherein the in-phase power module comprises:
- 2 a multiplier operably coupled to square the baseband in-phase components to produce squared in-3 phase values: and
- an accumulator operably coupled to accumulate the squared in-phase values for a predetermined 4 5 period of time to produce the power of the baseband in-phase components.

| 1 | 15. | (Original) The RFIC of claim 12, wherein the quadrature power module comprises: | |
|----|------------------------|---|--|
| 2 | | a multiplier operably coupled to square the baseband quadrature components to produce squared | |
| 3 | quadrature values; and | | |
| 4 | | an accumulator operably coupled to accumulate the squared quadrature values for a | |
| 5 | predete | ermined period of time to produce the power of the baseband quadrature components. | |
| 1 | 16. | (Original) The RFIC of claim 12, wherein the cross-correlation power module comprises: | |
| 2 | | a multiplier operably coupled to multiply the baseband in-phase components and the baseband | |
| 3 | quadra | ture components to produce cross-correlation values; and | |
| 4 | | an accumulator operably coupled to accumulate the cross-correlation values for a predetermined | |
| 5 | period | of time to produce the cross-correlation power. | |
| 1 | 17. | (Original) A radio frequency integrated circuit (RFIC) comprises: | |
| 2 | | receiver section operably coupled to convert inbound radio frequency (RF) signals into inbound | |
| 3 | baseba | nd signals; | |
| 4 | | transmitter section operably coupled to convert outbound data into outbound RF signals, wherein | |
| 5 | the tran | nsmitter section includes: | |
| 6 | | baseband processor operably coupled to convert the outbound data into the baseband in- | |
| 7 | | phase components and baseband quadrature components; | |
| 8 | | orthogonal-normalizing module operably coupled to: | |
| 9 | | obtain a first coefficient that is based on at least one of a gain imbalance and | |
| 10 | | phase imbalance; | |
| 11 | | obtain a second coefficient that is based on at least one of the gain imbalance and | |
| 12 | | the phase imbalance; | |
| 13 | | normalize an orthogonal relationship between the baseband in-phase components | |
| 14 | | and the baseband quadrature components based on the first coefficient and the second | |
| 15 | | coefficient to produce normalized in-phase components and normalized quadrature | |
| 16 | | components; | |
| 17 | | up-conversion module operably coupled to convert the normalized in-phase components and | |
| 18 | normal | ized quadrature components into RF signals; and | |
| 19 | | power amplifier operably coupled to amplify the RF signals to produce the outbound RF signals. | |
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- 1 18. (Original) The RFIC of claim 17, wherein the orthogonal-normalizing module comprises:
- 2 a first multiplier module operably coupled to multiple the baseband in-phase components with the
- 3 first coefficient to produce the normalized in-phase components:
- 4 a second multiplier module operably coupled to multiple the baseband in-phase components with 5 the second coefficient to produce cross coupled in-phase components; and
 - a subtraction module operably coupled to subtract the cross coupled in-phase components from the baseband quadrature components to produce the normalized quadrature components.
- 1 19. (Original) The RFIC of claim 18, wherein the first multiplier module comprises:
- 2 a first plurality of shift registers operably coupled to produce a plurality of shifted representations 3 of the baseband in-phase components:
- 4 switch matrix operably coupled to pass selected ones of the plurality of shifted representations of 5 the baseband in-phase components and the baseband in-phase components based on the first coefficient; 6 and
- 7 an adder operably coupled to add the selected ones of the plurality of shifted representations of 8 the baseband in-phase components and the baseband in-phase components to produce the normalized in-9 phase components.
- 1 20. (Original) The RFIC of claim 18, wherein the second multiplier module comprises:
- 2 a first plurality of shift registers operably coupled to produce a plurality of shifted representations 3 of the baseband in-phase components;
- 4 switch matrix operably coupled to pass selected ones of the plurality of shifted representations of 5 the baseband in-phase components based on the second coefficient; and
 - an adder operably coupled to add the selected ones of the plurality of shifted representations of the baseband in-phase components to produce the cross coupled in-phase components.
 - 21. (Original) The RFIC of claim 17, wherein the orthogonal-normalizing module comprises:
- 2 a first multiplier module operably coupled to multiply the baseband in-phase components with the second coefficient to produce cross coupled in-phase components; 3
- 4 a subtraction module operably coupled to subtract the cross coupled in-phase components from 5 the baseband quadrature components to produce phase adjusted quadrature components; and
- 6 a second multiplier module operably coupled to multiply the phase adjusted quadrature
- components with the first coefficient to produce the normalized quadrature components, wherein the 7 8
 - baseband in-phase components are passed as the normalized in-phase components.

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22. (Currently Amended) The RFIC of claim 17, wherein the orthogonal-normalizing module

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- 3 a first programmable register for storing the first coefficient; and
- 4 a second programmable register for storing the second coefficient, wherein the first and second
- 5 coefficients are determined by a trail and error trial and error manufacturing test of the gain imbalance
- 6 and the phase imbalance.
- (Original) The RFIC of claim 17, wherein the orthogonal-normalizing module comprises:
- 2 a full matrix multiply module operably coupled to multiply the baseband in-phase components
- 3 and the baseband quadrature components with a coefficient matrix that includes the first and second
- 4 coefficients to produce the normalized in-phase components and the normalized quadrature components.

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reference component; and

components to the reference component.

| 3 | measure local oscillation leakage power to produce a first power measurement; | | |
|----|---|--|--|
| 4 | provide a first magnitude signal to an in-phase portion of the transmitter section and a zero | | |
| 5 | magnitude signal to a quadrature portion of the transmitter section; | | |
| 6 | measure power of the in-phase portion and power of the quadrature portion while processing the | | |
| 7 | first magnitude signal and the zero magnitude signal, respectively, to produce a second power | | |
| 8 | measurement; | | |
| 9 | provide the first magnitude signal to the quadrature portion of the transmitter section and the zero | | |
| 10 | magnitude signal to the in-phase portion of the transmitter section; | | |
| 11 | measure the power of the in-phase portion and the power of the quadrature portion while | | |
| 12 | processing the zero magnitude signal and the first magnitude signal, respectively, to produce a third | | |
| 13 | power measurement; | | |
| 14 | determine the gain imbalance based on the first, second, and third power measurements; | | |
| 15 | provide a second magnitude signal to the in-phase portion and to the quadrature portion; | | |
| 16 | measure the power of the in-phase and quadrature portions while processing the second | | |
| 17 | magnitude signal to produce a fourth power measurement; | | |
| 18 | provide the second magnitude signal to the in-phase portion and a negative second magnitude | | |
| 19 | signal to the quadrature portion; | | |
| 20 | measure the power of the in-phase portion and the power of the quadrature portion while | | |
| 21 | processing the second magnitude signal and the negative second magnitude signal, respectively, to | | |
| 22 | produce a fifth power measurement; and | | |
| 23 | determine the phase imbalance based on the first, fourth, and fifth power measurements. | | |
| 1 | 25. (Original) The RFIC of claim 17, wherein the orthogonal-normalizing module normalizes the | | |

(Original) The RFIC of claim 17, wherein the orthogonal-normalizing module further functions

orthogonal relationship between the baseband in-phase components and the baseband quadrature

selecting one of the baseband in-phase components and the baseband quadrature components as a

normalizing another one of the baseband in-phase components and the baseband quadrature

- 1 26. (Original) The RFIC of claim 17, wherein the orthogonal-normalizing module further functions 2 to:
- 3 update the first and second coefficients to compensate for at least one of temperature variation 4 and aging.
- 1 27. (Original) A method for orthogonal normalization of a radio frequency integrated circuit (RFIC), 2 the method comprises:
- 3 determining phase imbalance and gain imbalance of a transmitter section of the RFIC;
- 4 normalizing baseband in-phase components and baseband quadrature components of the 5
- transmitter section based on the phase imbalance and the gain imbalance of the transmitter section:
- 7 providing a test signal from the transmitter section to the receiver section;
- 8 determining power of baseband in-phase components, power of baseband quadrature components,

coupling the transmitter section to a receiver section of the RFIC in a loop back configuration;

- 9 and cross-correlation between the baseband in-phase components and the baseband quadrature
- 10 components of the receiver section while processing the test signal; and
- 11 normalizing the baseband in-phase components and the baseband quadrature components of the 12 receiver section based on the power of the baseband in-phase components, the power of the baseband 13 quadrature components, and the cross-correlation between the baseband in-phase components and the
- 14 baseband quadrature components.

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- 1 28. (Original) The method of claim 27, wherein the normalizing the baseband in-phase components 2 of the receiver section comprises:
- 3 multiplying the baseband in-phase components with the first coefficient to produce the 4 normalized in-phase components;
- 5 multiplying the baseband in-phase components with the second coefficient to produce the cross-6 correlation; and
- 7 subtracting the cross-correlation from the baseband quadrature components to produce the 8 normalized quadrature components.

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2 of a transmitter section comprises: 3 measuring local oscillation leakage power to produce a first power measurement: 4 providing a first magnitude signal to an in-phase portion of the transmitter section and a zero 5 magnitude signal to a quadrature portion of the transmitter section; 6 measuring power of the in-phase portion and power of the quadrature portion while processing 7 the first magnitude signal and the zero magnitude signal, respectively, to produce a second power 8 measurement: 9 providing the first magnitude signal to the quadrature portion of the transmitter section and the 10 zero magnitude signal to the in-phase portion of the transmitter section: 11 measuring the power of the in-phase portion and the power of the quadrature portion while 12 processing the zero magnitude signal and the first magnitude signal, respectively, to produce a third 13 power measurement: 14 determining the gain imbalance based on the first, second, and third power measurements; providing a second magnitude signal to the in-phase portion and to the quadrature portion; 15 measuring the power of the in-phase and quadrature portions while processing the second 16 17 magnitude signal to produce a fourth power measurement; 18 providing the second magnitude signal to the in-phase portion and a negative second magnitude 19 signal to the quadrature portion; 20 measuring the power of the in-phase portion and the power of the quadrature portion while 21 processing the second magnitude signal and the negative second magnitude signal, respectively, to 22 produce a fifth power measurement; and 23 determining the phase imbalance based on the first, fourth, and fifth power measurements. 1 30. (Original) The method of claim 27, wherein the determining the power of baseband in-phase 2 components, the power of baseband quadrature components, and the cross-correlation comprises: 3 measuring in-phase signal level of the receiver section while processing the test signal; measuring 4 quadrature signal level of the receiver section while processing the test signal; 5 determining the power of the baseband in-phase components based on the in-phase signal level; 6 determining the power of the baseband quadrature components based on the quadrature signal 7 level; and 8 determining cross-correlation power based on the in-phase signal level and the quadrature signal

(Original) The method of claim 27, wherein the determining phase imbalance and gain imbalance

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(Original) The method of claim 27 further comprises:

repeating the normalizing of the transmitter section and the receiver section to fine tune an orthogonal relationship between the baseband in-phase components and baseband quadrature components of the transmitter section and an orthogonal relationship between the baseband in-phase components and baseband quadrature components of the receiver section.

1 32. (Original) The method of claim 27 further comprises, in an ordered sequence:
2 coupling the transmitter section to the receiver section in the loop back configuration;
3 providing the test signal from the transmitter section to the receiver section;
4 determining the power of baseband in-phase components, the power of baseband quadrature
5 components, and the cross-correlation between the baseband in-phase components and the baseband
6 quadrature components of the receiver section while processing the test signal;
7 normalizing the baseband in-phase components and the baseband quadrature components of

normalizing the baseband in-phase components and the baseband quadrature components of the receiver section based on the power of the baseband in-phase components, the power of the baseband quadrature components, and the cross-correlation between the baseband in-phase components and the baseband quadrature components;

determining the phase imbalance and the gain imbalance of the transmitter section;

normalizing baseband in-phase components and baseband quadrature components of the
transmitter section based on the phase imbalance and the gain imbalance of the transmitter section; and
repeating the ordered sequence of normalizing of the receiver section and the transmitter section
to fine tune an orthogonal relationship between the baseband in-phase components and baseband quadrature components of the receiver section and an orthogonal relationship between the baseband inphase components and baseband quadrature components of the transmitter section.